In the Drawings:

Please replace the single Original Sheet with the enclosed 1 Replacement Sheet bearing revised Figs. 1 and 2, in which "8" has been added to Fig. 1 and erroneous "12" has been changed to "13", and "11" has been added to Fig. 2. Please also enter the enclosed 1 New Sheet bearing a new Fig. 3 according to claim 3 and the description at page 11 lines 14 to 27.

[RESPONSE CONTINUES ON NEXT PAGE]

REMARKS:

1) In accordance with the PCT procedures, the original specification and abstract of this application were based on a direct literal translation of the corresponding foreign-language PCT application text. The specification and abstract have now been amended editorially and formally to better meet US application style and formal requirements (e.g. adding section headings and avoiding the use of claim numbers in the written description). A few clerical corrections have also been made. The specification has also been supplemented to refer to the new Figure 3 that has been added to the drawings. The abstract has been shortened and editorially amended to meet the US requirements. These merely formal amendments do not introduce any new matter. Entry thereof is respectfully requested.

2) The drawings have been amended as set forth in the above drawing amendment section, basically by correcting a few minor errors in reference numbers in Figs. 1 and 2, and by adding Fig. 3 to illustrate the subject matter of original claim 3 and the original written description at page 11 line 14 to page 12 line 3. Thus, the drawing amendment does not introduce any new matter. Entry thereof is respectfully requested.

3) The original claims 1 to 3 have been maintained without amendment. New claims 4 to 9 have been added to cover inventive subject matter with slightly different claim terminology, format and style in comparison to the original literally translated PCT

claims 1 to 3. The new claims are supported by the original disclosure as shown in the following table, and do not introduce any new matter. Entry and consideration thereof are respectfully requested.

new claims	4	5	6	7	8	9
original support	cl 1; Figs.1,2,3; pg 5 ln 14 - pg 12 ln 3	Figs. 1,2	cl 3; Fig. 3; pg 11 ln 14- pg 12 ln 3	cl 2	cl 3; Fig. 3	cl 2; pg 10 ln 8-27

4) Referring to section 1 on page 2 of the Office Action, the specification has been formally amended as discussed above. The specification now conforms to the US guidelines. Please withdraw the objection to the disclosure.

5) Referring to section 5 on pages 4 and 5 of the Office Action, the indication of allowable subject matter in original claim 3 is appreciated. Claim 3 has been maintained without amendment, so that claim 3 should still be seen as reciting allowable subject matter. Also, new claim 8 recites the indicated allowable subject matter of original claim 3, so that claim 8 should also be recognized as containing allowable subject matter. Furthermore, for the reasons that will be discussed below, it is respectfully submitted that independent claims 1 and 4 are also patentable over the prior art.

6) Before specifically addressing the prior art rejections and comparing the claimed features of the invention with the prior art disclosures, the invention will first be discussed in general terms to provide a background.

An object of the present invention is to provide an arrangement for measuring torque, in which the measurement signal is frequency modulated and transmitted from a rotor to a stator, whereby the accuracy is improved especially at higher signal bandwidths and high modulation frequencies, while sensitivity errors are reduced. One important feature of the inventive arrangement for achieving this object is the use of a **synchronous** voltage-frequency converter to convert the analog voltage signal produced by the strain measuring bridge to a frequency-proportional signal. A further important feature is the use of a phase-locked loop synchronization circuit to suppress frequency jitter in the converted frequency signal. See the specification at page 3 line 24 to page 4 line 23.

These two features go hand-in-hand or interact with one another to achieve a greatly increased accuracy and insensitivity to null point errors.

In the prior art it has been known to use a **conventional** voltage-frequency converter having a time behavior determined by resistive and capacitive elements to convert an analog measurement signal into a continuously variable frequency. However, such conventional voltage-frequency converters suffer temperature dependent linearity errors. To avoid that problem, the invention uses a **synchronous** voltage-frequency converter that is controlled or regulated by an external constant input

frequency, rather than using RC elements for determining the dynamic time behavior. For example, the constant reference frequency is supplied by a quartz-controlled frequency generator. That arrangement can provide an accuracy that is tens or hundreds of times higher than conventional voltage-frequency converters. See the specification at page 6 line 1 to page 7 line 6.

However, an inherent limitation of a synchronous voltage-frequency converter is that it can change its output frequency only in discrete frequency steps and does not offer the desired or required continuously tuneable frequency range for producing an output frequency signal proportional to the continuously variable analog input voltage. See the specification at page 7 line 7 to page 8 line 6.

So, in the context of converting an analog measurement voltage signal to a proportional frequency, it would seem that a synchronous voltage-frequency converter is entirely unsuitable, because the required proportional output frequency can only be approximated as an average value over time, by switching back-and-forth between available discrete frequencies, to provide an averaged frequency between two of the available discrete output frequencies. Such frequency switching or alternation produces frequency jitter that reduces the possible signal resolution to such a degree that it is not suitable for highly accurate torque measurements. To overcome that problem, the invention further provides the phase-locked loop synchronization circuit downstream from the synchronous voltage-frequency converter to suppress the frequency jitter and produce a smoothed

output frequency. See the specification at page 7 line 6 to page 9 line 13.

The prior art does not disclose and would not have suggested this inventive combination of a **synchronous** voltage-frequency converter and a PLL following synchronization circuit for converting an analog torque measurement voltage signal to a proportional frequency signal that can be transmitted in a contactless manner from a rotor to a stator. Such a combination would not even have made sense in the context of the prior art, for the reasons that will be discussed below.

7) Referring to section 3 on pages 3 and 4 of the Office Action, the rejection of claim 1 as obvious over US Patent Application Publication US 2004/0123678 (Arai) in view of US Patent 5,982,835 (Kim et al.) is respectfully traversed.

Present claim 1 is directed to an arrangement for measuring torque of rotating machine parts, including a **synchronous** voltage-frequency converter and a follow-up synchronization circuit (PLL) connected after the synchronous voltage-frequency converter. The special inventive advantages achieved by this combination have been discussed generally above. For example, the synchronous voltage-frequency converter (which uses an external reference frequency) can achieve a much greater accuracy than a conventional voltage-frequency converter (which uses resistive and capacitive elements for controlling the dynamic time behavior). However, by itself a synchronous voltage-frequency converter would seem unsuitable for converting the continuously variable analog measurement signal of the strain

measuring bridge, because it cannot produce a continuously variable frequency output, but rather only discrete frequencies at discrete frequency steps. To produce an average output with the required frequency, the output alternates between adjacent available discrete frequencies, but that produces a frequency jitter. For that reason, the PLL synchronization circuit is provided to suppress the frequency jitter. Such a combination of features is not disclosed and would not have been suggested by the prior art.

Arai discloses a torque measuring device that includes a strain measuring bridge followed by a voltage-frequency converter. However, contrary to the present invention, the **conventional** voltage-frequency converter according to Arai is **NOT** a **synchronous** voltage-frequency converter that uses an external reference frequency. Also, the arrangement of Arai does **not** include a PLL synchronization circuit connected after the voltage-frequency converter, as acknowledged by the Examiner.

A person of ordinary skill in the art considering the arrangement of Arai would have found no suggestion or motivation, and no common sense reason, for considering to use a PLL synchronization circuit after the voltage-frequency converter. The disclosed voltage-frequency converter is **NOT** a **synchronous** voltage-frequency converter, but instead is a conventional voltage-frequency converter apparently using RC elements to determine the dynamic time behavior and the frequency conversion. Therefore, the conventional voltage-frequency converter according to Arai can produce a continuously variable output frequency proportional to the input voltage, and there is no need for

alternating between discrete frequencies to achieve an average representation of the actual required frequency. Thus, the output of the voltage-frequency converter of Arai does **not** suffer a frequency jitter, and there would be no reason to provide a PLL synchronization circuit to suppress a non-existent frequency jitter. Also, no other reason or purpose or advantage would be achieved by providing a PLL synchronization circuit after the voltage-frequency converter that is (by itself) already able to produce a stable output frequency proportional to the input voltage. For these reasons, a person of ordinary skill in the art considering the arrangement of Arai would not have further considered the disclosure of Kim et al. as proposed by the Examiner.

The Examiner has cited Kim et al. for disclosing a PLL synchronization circuit for jitter suppression. It is true that Kim et al. disclose the general concept of a PLL circuit for jitter suppression. However, that PLL circuit is not used in connection with a synchronous voltage-frequency converter for converting a continuously variable measurement signal into a proportional frequency signal. Instead, the PLL circuit of Kin et al. is used in a microwave transmitter. Thus, a person of ordinary skill in the art considering the Kim et al. disclosure together with the Arai disclosure would still have found no suggestion or motivation to couple a PLL synchronization circuit for frequency jitter suppression after a synchronous voltage-frequency converter. The only suggestion in this regard used by the Examiner seems to be the hindsight understanding of

the present invention, applied to reassemble the invention from disparate components in the two prior art references.

In more detail, the teachings of Arai and Kim et al. would not have suggested the present inventive combination for the following reasons.

According to Arai, the measurement signal is converted into a frequency signal and then converted into a light signal that is transmitted from the rotor to the stator. Therefore, the measurement signal is only converted into a low frequency signal by the voltage-frequency converter, and is then further converted into a high frequency light signal. Since no high frequency frequency-modulated electrical measurement signal exists in Arai, but rather a light signal is transmitted from the rotor to the stator, it was not necessary and would not have been suggested to use a synchronous voltage-frequency converter for the frequency conversion, and it would not have been necessary or suggested to use a PLL synchronization circuit. Such a combination of circuit components would not have served the required purposes of Arai. There would have been no reason to provide measures for stabilizing the modulation frequency using a synchronous voltage-frequency converter followed by a PLL synchronization circuit.

On the other hand, the Kim et al. reference involves a phase synchronization of a digital microwave transmitter circuit, in which an input frequency of 8 KHz is stepped-up to an output frequency of 19.44 MHz, which has no relation to the conversion of a strain measurement voltage signal to a proportional frequency signal in a synchronous voltage-frequency converter.

Thus, the teachings of Kim et al. regarding a PLL circuit for jitter suppression in a microwave transmitter circuit would not have taught the ordinarily skilled artisan anything about circuit components to use in a circuit for measuring torque of a rotating machine part. The problem of frequency jitter caused by a synchronous voltage-frequency converter in the context of the present invention (converting an analog voltage measurement signal) would have had no relation and would not have been suggested by the disclosure of Kim et al. Thus, the disclosure of Kim et al. also would have provided no suggested solution for such a problem.

In view of the above, even a combined consideration of the two references would not have made the present invention obvious.

For the above reasons, the Examiner is respectfully requested to withdraw the rejection of claim 1 as obvious over Arai in view of Kim et al.

8) Referring to section 4 on page 4 of the Office Action, the rejection of claim 2 as obvious over Arai and Kim et al. further in view of US Patent 3,588,676 (Tschopp and Keller) is respectfully traversed. Claim 2 depends from claim 1, which has been discussed above in comparison to Arai and Kim et al. The Examiner has further cited Tschopp and Keller for disclosing a quartz controlled frequency oscillator. However, the quartz oscillator is used in a nuclear magnetic resonance spectrograph, which has no relation whatsoever to an apparatus for measuring torque of a rotating machine part, in connection with a synchronous voltage-frequency converter. Instead, the quartz

oscillator generates a frequency signal that serves to stabilize the magnetic field and serves as a median frequency of a frequency sweep to obtain the nuclear magnetic resonance spectra according to Tschopp and Keller. That would not have provided any suggestions to connect a quartz controlled frequency generator to a synchronous voltage-frequency converter for converting a measurement voltage signal to a frequency signal. In the reference, the quartz controlled frequency is not applied to the voltage-frequency converter, but rather to a mixer and from there to a phase detector downstream of the voltage-frequency converter (see Fig. 4). Thus, even a combination of all of the references would not have suggested the additional features of claim 2 further in combination with the features of claim 1. The Examiner is respectfully requested to withdraw the rejection of claim 2 as obvious over Arai in view of Kim et al. and further in view of Tschopp and Keller.

9) The new claims also define a patentable combination over the prior art. New independent claim 4 is directed to an apparatus for measuring torque including a synchronous voltage-frequency converter and a phase-locked loop connected downstream from the output of the converter. Thus, the same distinctions from the prior art as discussed above also apply to claim 4. The new dependent claims 5 to 9 recite additional features that further distinguish the invention over the prior art. Entry and favorable consideration thereof are respectfully requested.

10) The additional prior art made of record requires no particular comments, because it has not been applied against the claims.

11) Favorable reconsideration and allowance of the application, including all present claims 1 to 9, are respectfully requested.

Respectfully submitted,
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